Sampling Strategies in Land Use

Mapping Using Skylab Data

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Monthly Progress Report

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Introduction

This investigation is designed to use Skylab/EREP A, S-192 multispectral scanner data and S-190 multispectral photography acquired over the Washington, D. C. - Baltimore and Alice Springs, Australia areas to examine those parameters influencing sampling strategies with respect to manual, semi-automated, or automated thematic land use mapping with spacecraft data.

Work performed this period was in the Washington, D. C. - Baltimore test site. As originally planned, the test site was to encompass an area approximately 159 miles long and 42 miles wide extending northwest to southeast over the Virginia - Maryland area, including the Washington, D. C. - Baltimore, Maryland corridor.

Orbital changes early in the mission resulted in the test site being shifted slightly to the southwest. The site includes large areas of southern Maryland and eastern Virginia as well as a small area of West Virginia.

Included in the 6,678 square mile test site are representative areas of various morphological characteristics including the piedmont section of Virginia and western Maryland, the deeply dissected coastal plain area of the western shore of Chesapeake Bay, and the very flat coastal areas of lower Delmarva Peninsula. Portions of Chesapeake Bay as well as estuaries of the Potomac and Patuxent Rivers are also within the test site.

In terms of land use, the test site exhibits a great diversity. Most of the Washington, D. C. metropolitan area is included in the site, which is an area of great urban-rural complexity, especially in the urban fringe areas where suburban development is encroaching on agricultural lands. The areas outside the Washington metropolitan area are largely agriculture-based, but contain large amounts of forest and wetland plant communities.

It was soon realized that the level of generalization of land use categories (i.e., gross, moderate, and detailed) originally proposed for use in this investigation were not descriptive enough and seemed difficult to relate to other areas in similar environments. In conjunction with other EARTH SAT land use projects, a land use inventory and classification scheme was adopted which provides informational needs that are responsive to many Federal and State agencies involved in land use planning. The land use classification scheme (Level I and II) used in this study was developed by the U. S. Geological Survey (Anderson, et al., 1972). The land use classification levels are based on interpretation of high altitude-small scale imagery and may be ambiguous relative to ground base interpretations. The level of generalization in the classification scheme, the small scale of the basic imagery, and the scale of reproduction of the final map are appropriate for maps illustrating regional land use patterns.

The classification scheme was developed on the assumption that different levels of classification would be derived from different sources of information and, in general, the relationship can be shown as:

Classification Level

I	Satellite imagery
II	High altitude and satellite imagery combined with topographic maps.
III	Medium altitude remote sensing (1:20,000) combined with detailed topographic maps and substantial amounts of supplemental information.
IV	Low altitude imagery with most of the information derived from supplemental sources.

Classification schemes for Level I and II are presented in Anderson, et al (1972). Level III and IV land use information is that which may only be obtained by careful interpretation of large scale imagery, and time consuming field work. Land use classification schemes for Level III and IV have been obtained through cooperative arrangements with the U. S. Geological Survey, Geographic Applications Program and with Dr. C. E. Olson, Jr., The University of Michigan, Ann Arbor, Michigan. These provide the basis for establishing a workable scheme suitable for the objectives of this project.

Status of Ground Truth Acquisition - Washington, D. C. Test Site

A sampling frame was developed for the Washington, D. C., test site to provide a 5 percent sample of the entire area for ground truth data collection. A systematic-unaligned, locationally stratified random design which has proved highly successful in land use studies (Holmes, 1967; Holmes, 1970) was selected. The systematic grid with cells of constant size provide locational spread, equal selection probability, and a statistical representative approach of randomness. The test site was divided into grid cells of approximately

16 square miles each on 1:250,000 map sheets. Each grid cell was then sub-
divided into sixteen, one square mile units, and a random number table was used
to generate the selection of a site within the 16 square mile grid.

After the selection of the sample plots, the one-square mile areas were
transferred from the 1:250,000 map sheets to existing RC-10 photography (See
Table 1). A polaroid MP-3 copy camera was then used to prepare enlargements
of the individual test sites for the field work. The photo enlargements
provided a valuable tool in locating sample plots, defining land use boundaries,
and simplifying the ground truth data collection effort.

Field work sheets where then prepared for Level III and IV information for
agricultural and urban areas (See Figures 1 and 2). These provided a consistent
reporting form for the field teams and can be easily transferred into computer
readable format.

The collection of ground truth data was divided into two sections: 1) changing
environments, i.e., agricultural areas; and 2) static environments, i.e., urban,
forest, and wetlands. Field work was conducted principally to obtain detailed
(Level III and IV) land use information in agricultural and urban areas.
Forest/vegetation maps are being supplied through a cooperative arrangement with
the Maryland Department of State Planning. These maps will provide detailed
forest and other natural vegetation information for the test site. Detailed
wetlands data are being provided through cooperative arrangements with other
ERTS-1 investigators in the area who have done extensive fieldwork and mapping
of the coastal wetlands in Maryland and Virginia.

FIGURE 1. AGRICULTURAL FIELD INVENTORY FORM

PLOT NO. _____

FIELD IDENT.	CROP TYPE				FENCED		ROW DIRECTION	CROP HEIGHT	ROW SPACING	GROWING STAGE																IRRIGATION			GRAZED PASTURE			TRANSPORT FACILITIES			
	GRAIN	PASTURE	ORCHARD	WRITE IN NAME	YES	NO	(WRITE IN)	FT/IN	FT/IN	GRAIN					PASTURE						ORCHARD					YES	NO	TYPE	YES	NO	ANIMAL TYPE	ROAD WIDTH FEET	NUMBER OF LANES	PAVEMENT TYPE	SHOULDER TYPE
										EMERGING	DEVELOPED	HEADED	OUT	STUBBLE	BLOOM	CUT	CUT-RAKE	BALED	STUBBLE	REGROWTH	BLOSSOM	FIRE	UNRIPE	PICKED	NONE										

FIGURE 2.   URBAN FIELD INVENTORY FORM

PLOT·NO:

IDENT.	TYPE (U.S.G.S Level 3)	DENSITY			LOT SIZE (feet)	NUMBER OF STORIES/ SHAPE (mobile homes)	SPACING (mobile home)				PARKING	DRIVEWAYS	SIDEWALKS	TYPE of MATERIAL	LAWN			RECREATION AREA			TRANSPORT FACILITIES			
		LOW	MEDIUM	HIGH			‖ to street	⊥ to street	CIRCULAR	OTHER					YES	NO	TYPE	YES	NO	TYPE	ROAD WIDTH feet	NUMBER OF LANES	PAVEMENT TYPE	SHOULDER TYPE

Ground truth data was collected for 303 square mile sample plots

in the Washington, D. C., test site. This is approximately 5 percent of the

total area of the test site, and 6 percent of the land area (See Table 2).

Sample plots were located in 20 counties in Maryland and Virginia, and the

District of Columbia. Using the USGS Level I Land Use Classification, the

303 plots can be classified as to predominant land use type:

> 175 - Agricultural Land
>
> 48 - Urban and Built-up Land
>
> 50 - Forest Land
>
> 30 - Non-forested Wetlands

A detailed breakdown of Level I plots by county is given in Table 3. The

detailed (Level III and IV) information obtained from field work and other

data sources will constitute the data base for detailed analyses in subsequent

periods.

TABLE 1.   GROUND TRUTH IMAGERY - WASHINGTON, D. C. TEST SITE

Type: RC-10, Color infrared

Scale: 1:130,000

Mission Number	Date	Frame
144	9-23-70	507, 519, 521
144	9-25-70	7236, 7238, 7260 7262, 7264, 7265 7276, 7298
72-209	12-3-72	6859, 6861, 6862 6863, 6865, 6882 6884, 6885, 6888 6889, 6891, 6893, 6896
73-010	1-26-73	7877, 7879, 8006 8007, 8009, 8011 8014, 8016, 8034
73-014C	1-31-73	8452, 8454, 8457 8459, 8461, 8463 8471, 8472, 8475 8477, 8478, 8479 8480, 8484, 8485 8486, 8488

TABLE 2.   WASHINGTON, D. C. TEST SITE AND SAMPLE DESCRIPTION

Test Site:

        Total Area: 6,678 square miles
         Land Area: 5,073 square miles
            Length: 159 miles
             Width: 42 miles

Sample Plots:

         Estimated: 335 (5% of total area)
            Actual: 303 (4.5% of total area)
                         (6% of land area)

TABLE 3. SAMPLE PLOTS BY COUNTY AND LEVEL I LAND USE CLASSIFICATION

County	Urban	Agriculture	Forest	Wetland	Total
Accomack	1	15	1	8	25
Anne Arundel	0	3	0	0	3
Calvert	2	2	7	0	11
Charles	0	15	10	0	25
D.C.-Arlington	5	0	0	0	5
Dorchester	0	11	3	12	26
Fairfax	13	2	6	0	21
Fauquier	1	19	0	0	20
King George	0	1	0	0	1
Loudoun	2	25	2	0	29
Montgomery	8	9	1	0	18
Prince Georges	9	9	4	0	22
Prince William	3	9	7	0	19
St. Mary's	2	19	5	0	26
Somerset	2	16	0	7	25
Stafford	0	0	1	0	1
Talbot	0	1	0	0	1
Washington	0	0	1	0	1
Westmoreland	0	2	0	0	2
Wicomico	0	5	1	0	6
Worcester	0	12	1	3	16
Total	48	175	50	30	303

Aircraft/Spacecraft Data Acquistion

NASA RB-57 aircraft overflights were requested over the Washington, D. C. - Baltimore test site within a week after it was known that acceptable multispectral photography and scanner data were obtained. The format and types of data requested from the SKYLAB missions are given in the technical proposal and will not be duplicated here.

SKYLAB data were obtained over the Washington, D. C. - Baltimore test site on 12 June, 1973 at approximately 0900 hours. Weather conditions were: clear skies, 80 degrees ground air temperature, 72% relative humidity, and SW winds at 10 knots. Preliminary indications are that acceptable multispectral photography and scanner data were obtained. No data has yet been received.

RB57 aircraft data were obtained over the Washington, D. C. - Baltimore test site on 14 June, 1973 at approximately 1200 hours. Weather conditions were: thin, scattered cirrus at 25,000 feet, 81 degrees ground air temperature, 30% relative humidity and 9 knot winds. The sensor configuration is shown below:

Camera	Lens Focal Length	Film Type	Filters
RC-8	6"	SO397	AV+2A
RC-8	6"	2443	AV+12
Zeiss	12"	2443	515 nm

Six flight lines were flown in a north-south direction at approximately 61,000 feet. No imagery from these overflights has been received and no information on image quality is available yet.

Next Period:

It is anticipated that detailed ground truth data collection will be completed during the next period. Preparation of detailed Level III and IV land use maps for selected areas will be initiated. Also, design of the field sampling plan for the Alice Springs, Australia, test site will be completed.

Selection and assessment of appropriate computer software will continue and detailed interpretation of NASA RB-57 aircarft data acquired on 14 June 1973 will be initiated when data is received.

Efforts will be continued to contact potential users in the area to make them cognizant of the project and to establish an exchange of information which will ultimately aid in meeting the objectives of this investigation in a manner which will provide information requirements responsive to the users needs.

Significant Results:

There are no significant results to report at this time.

Literature Cited

Anderson, J. R., E. E. Hardy, and J. T. Roach. (1973). A Land-Use Classification System for Use with Remote Sensor Data. U. S. Geological Survey Circular 671. 16 pp.

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